



RECLAMATION OF TWO COAL MINES IN MONGOLIA: THE EREN MINE AND THE PLANNED TAVAN TOLGOI MINE

By

Steve Williams, Vern Pfannenstiel and Ariunaa Jalsrai

ALL PHOTOGRAPHS ARE BY SEW EXCEPT WHERE NOTED.

AUTHORS

Steve Williams: The University of Wyoming, Laramie

Vern Pfannenstiel: Peabody Energy, Flagstaff

Ariunaa Jalsrai: The Mongolian Academy of Science, Ulaanbataar

Acknowledgements

(from 1986 through the present, partial listing)

- The Rockefeller Foundation*
- The UW International Program Office (under Dr. Wenberg Chai** and now Dr. Anne Alexander*)
- The Asian Development Bank (through the Consortium for International Development)***
- The UW Environment and Natural Resources Program (Under Dr. Ingrid Burke)*
- The College of Agriculture and Animal Husbandry in Hohhot, Inner Mongolia (Mr. Dalai)*
- The International Research Exchange (IREX) in Washington DC*
- The School of Foreign Service at Georgetown University (Dr. James Reardon-Anderson).
- The Nature Conservancy Mongolia (Ikhtuya and Galbadrakh Davaa) and Wyoming.
- Mongolian Academy of Sciences (Dr. Ariunaa Jalsrai)
- Mongolian Academy of Sciences (Dr. Ravjagiin Baatar)
- The Chinese Academy of Sciences
- Mongolian State University of Agriculture, Darkhan Uul, Research and Training Institute of Plant Science and Agriculture (Dr. Bayarmagnai Jalsrai, Director)*
- The Johnson Foundation at Wingspread*
- The UW Graduate School*
- UW Department of Plant, Soil and Insect Sciences*
- UW Department of Renewable Resources*
- Peabody Coal Company in Mongolia (especially Mr Altengeral and Mr. Vern Pfannensteil)
- The Chinese Academy of Forestry (Dr. Guo Xiuchen and Dr. Zipeng Zhao)*
- *Entities that funded significant travel. The number of stars indicate the number of times funded.

Acknowledgements

Support in 2010

- The UW International Program Office (Anne Alexander*)
- The UW Environment and Natural Resources Program (Under Ingrid Burke)*
- Mongolian Academy of Sciences (Dr. Ariunaa Jalsrai)
- Mongolian State University of Agriculture, Darkhan Uul, Research and Training Institute of Plant Science and Agriculture (Dr. Bayarmagnai Jalsrai, Director)*
- UW Department of Renewable Resources*
- Peabody Coal Company in Mongolia (especially Mr Altengeral and Mr. Vern Pfannenstiel)
- *Entities that funded significant travel.

CONTENTION

- MONGOLIA HAS BEEN VIEWED IN RECENT HISTORY AS A LOW POPULATION, WEAK COUNTRY SUBSERVIENT TO NEIGHBORS.
- NOW THE VIEW IS THIS NEW DEMOCRACY WILL DETERMINE MUCH OF WHAT HAPPENS ECOLOGICALLY, HYDROLOGICALLY AND ECONOMICALLY IN THE REGION LARGELY DUE TO ITS LOCATION BUT ALSO DUE TO ITS RESERVES OF MINERALS AND HYDROCARBONS.

MONGOLIA'S CONUNDRUM: CONSERVATION VERSUS DEVELOPMENT.





OBJECTIVES

- GEOGRAPHY, HISTORY, POLITICS
- ECOLOGICAL MONGOLIA.
- OTHER ECOSYSTEM RESOURCES
- NON-RENEWABLE NATURAL RESOURCES
- MITIGATION OF ECOSYSTEM DISRUPTION ASSOCIATED WITH NATURAL RESOURCE DEVELOPMENT

GEOGRAPHY, HISTORY, POLITICS



MONGOLIA POLITICAL BOUNDARIES



Base 802442 (B00730) 3-96

MONGOLIAN CITIES



Base 802442 (B00730) 3-96



ULAANBAATAR, CITY OF 1.5 MILLION IN A COUNTRY OF 3.5 MILLION. OTHER LARGE CITIES NEARBY IN RUSSIA INCLUDE ULAN-UDE AND IRKUTSK.

MONGOLIA, EVEN WITH ULAANBAATAR, HAS THE LOWEST POPULATION DENSITY OF ANY COUNTRY IN THE WORLD!

MONGOLIA'S MOST IMPORTANT HISTORICAL POLITICAL BOUNDARY



Base 802442 (B00730) 3-96



THE GREAT WALL OF CHINA (GWC) NEAR BADALING.

ECOLOGICAL MONGOLIA



VEGETATIVE ASSOCIATIONS



Base 802442 (B00730) 3-96

Steppe Desert Ppt <100 mm/Yr

Desert Steppe PPt 170 mm/Yr

> Typical Steppe Ppt 270 mm/Yr

Meadow Steppe Ppt 350 mm/Yr Forest Steppe Ppt > 400 mm/Yr

Dominant Grass Species and Moisture Gradient Across the Mongolian Steppe



Tumenstogt, Mongolia





Soil Organic Matter (0-15 cm) as a function of Annual Precipitation



Williams, Dodd & Lockwood, 1994.

Typical Steppe Soil Characteristics

- Taxonomy: Melanic (NZ), Dark Chestnut (Russian), Mollisols (USA).
- Texture: 70% sand, 15% silt, 15% clay.
- Deep mollic (organic) epipedon: 50 to 200 cm ightarrow
- Organic Matter: 2 to 4% in top 20 cm ightarrow
- pH: 7.5
- Electrical Conductivity: 0.5 dS/cm
- Nitrate: 15 micrograms/g
- Phosphorus: 3 micrograms/g
- olant Available Potassium: 150 micrograms/g





HYDROLOGICAL MONGOLIA



Base 802442 (B00730) 3-96



HOVSGOL NUUR (LAKE). 1645 M ELEVATION, 70% OF MONGOLIAS FRESH WATER

RIVER CROSSING

ERGIIN GOL, EXITS HOVSGOL LAKE.



SELENGE RIVER



PHOTO BY SVETLANA L. TCHISTIAKOVA



LAKE BAIKAL,
MAXIMUM DEPTH 1637 M
AVERAGE DEPTH OF 773 M
WORLD'S LARGEST VOLUME OF FRESH WATER.
25 TO 30 MILLION YEARS OLD
ELEVATION AT 445 M.

CONSIDERABLE POTENTIAL EXISTS FOR CONTAMINATION OF BAIKAL POSED BY MERCURY PLACER IN MONGOLIA (TUMENBAYAR, BATBAYAR & GRAYSON, 2000).

THERE IS MUCH POLLUTION ALSO ENTERING THE SELENGE WATERSHED FROM MUNICIPLE AND INDUSTRIAL WASTES GENERATED BY DEVELOPING CITIES SUCH AS ULAN UDE (RUSSIA) AND ULAANBAATAR (MONGOLIA).



TUUL RIVER UPSTREAM FROM ULAANBAATAR







OTHER ECOSYSTEM RESOURCES





HOVSGOL NATIONAL PARK.

GREATER THAN 9,000 SQ KM

WILDLIFE RESOURCES; IBEX, ARGALI, ELK, WOLF, WOLVERINE, MUSK DEER, BROWN BEAR, SIBERIAN MOOSE, SABLE.

FISH: EURASIAN PERCH, BURBOT, LENOK, HOVSGOL GRAYLING.



HOVSGOL, SOUTH SHORE.



BLUE CRANES





GORKHI-TERELJ NATIONAL PARK NEAR ULAANBAATAR.



SAND LANDS ON NORTH EAST BORDER OF GOVI.

PHOTOGRAPH BY ARIUNA JALSRAI.



PRECIPITOUS ZONE IN GOVI.

PHOTOGRAPH BY ARIUNA JALSRAI.



TAKI (PRESWALSKI'S HORSE) IN KHUSTAI NATIONAL PARK

THE RUB

- MONGOLIA HAS A LONG HISTORY OF CONNECTION TO AND DEPENDENCY ON ECOSYSTEM SERVICES.
- HER ECONOMY IS INCREASINGLY DRIVEN, HOWEVER, BY MINING AND EXTRACTION DEVELOPMENT.
- OUTSIDERS DESIRE TO PURCHASE THESE MINED PRODUCTS BUT BAULK AT ENVIRONMENTAL ACCOUNTABILITY.

NON-RENEWABLE NATURAL RESOURCES







GERS AT THE EDGE OF THE ERDENET COPPER MINE IN CENTRAL MONGOLIA.



BAGANUU COAL MINE. THIS MINE PROVIDES MOST OF THE COAL FOR HEATING IN ULAANBAATAR.



NINJA MINERS ON THE TUUL RIVER NEAR ZAAMAR PANNING FOR PLACER GOLD.

MITIGATION OF ECOSYSTEM DISRUPTION ASSOCIATED WITH NATURAL RESOURCE DEVELOPMENT



THE TAVAN TOLGOI AND THE EREEN MINE





THE TAVAN TOLGOI



-IN THE GOVI DESERT -VERY LOW PRECIPITATION -HIGHLY ERATIC PRECIPITATION -PROBLEMATIC SOILS



TYPICAL DEEP GOVI



SOIL SURFACE: GOVI

SOME SOIL PROPERTIES AT TAVAN TOLGOI

рН	рН	Texture	E. C.	Coarse
1 to 1	1 to 10		dS/m	Fragments
8.7	9.4	SCL	4 to 8	15%
9.1	9.9	SC	2 to 4	0
8.4		SC	4 to 8	15%
9	9.4	SC	<2	25%
8.4		S	>32	<5%
8		SC	>32	5%
8.8	9.2	CS	<2	<5%
8.7	9.1	SCL	<2	<5%
8.4		SiC	<2	0
8.3		С	<2	0
8.4		С	<2	<5%
8.2		С	8 to 16	0
7.8		SC	8 to 16	30%
7.8		SC	16 to 32	50%
8		S	4 to 8	0



KEYSTONE SPECIES IN THE GOVI: SAXUL (HALOXYLON AMMODENDRON)



THE TAVAN TOLGOI OFFICIALLY HAS NO ACTIVE MINES

THE EREEN MINE



-BULGAN GRASSLAND

-HIGH PRECIPITATION

-FAVORABLE SOILS



Photograph Peabody

THE EREEN MINE IN 2008 PRIOR TO INITIATION OF RECLAMATION



Peabody Energy Photograph

EREEN MINE SITE NEAR FINAL COMPLETION IN MAY 2010.

SALVAGING AND RESPREADING SUITABLE SOIL

Peabody Energy Photograph

ANALYSIS OF SALVAGED SOIL

Parameter	Average	Standard	n
		Deviation	

рН	7.96	0.65	7
Carbonate, %	2.24		1
EC, dS/m	0.108	0.029	7
%N	0.64	0.18	7
%OC	4.46	1.26	7
% Humus	7.69	2.17	7
NO3, mg/100g	0.419		1
P2O5, mg/100g	1.77	0.94	7
K20, mg/100g	19.71	4.89	7
<2.0, %	15.15	3.49	7
<0.2, %	53.3	2.24	7
<0.02, %	24.69	2.17	7
<0.002, %	6.84	4.2	7



MAP OF THE RECLAIMED AREA: 14.25 Ha.



SEEDING USING A JOHN DEERE RANGELAND DRILL.

SEED AND SEEDING RATES

Name of plants		Seed normative		1000	Seed
Latin	Mongolian	kg/ha	g/m²	seed weight, gram	planted in 1m ² , piece
Medicago varia	Эрлийз царгас	0,6	0.06	2.1	28
Bromis inermis	Соргүй согоовор	3,4	0.34	3.5	97
Agropyron cristatum	Саман ерхөг	3,7	0.37	3.0	123
Stipa sibiricis	Сибирь хялгана	2,3	0.23	3.3	70
Tota	al:	10.0	1.0		318



Medicago varia

Bromus inermis





Stipa sibericis

Agropyron cristatum



Peabody Energy Photographs



THE EREEN MINE IS NOW A RESEARCH AND MONITORING SITE USED BY MONGOLIAN UNIVERSITIES AND A LOCATION FOR INSTRUCTION OF STUDENTS AND PROFESSIONALS.

VEGETATIVE CHARACTERISTICS OF THE EREEN MINE SITE IN 2012.

- VEGETATITVE COVER ON RECLAIMED SITE IS VERY HIGH.
- MORE THAN 40 NATIVE SPECIES HAVE BEEN FOUND ON THE RECLAIMED SITE
- ABOVE GROUND HARVESTABLE PLANT BIOMASS IS ABOUT FOUR TIMES THAT ON NATIVE AREAS.



MUCH MONITORING WORK AND EFFORTS TO COMPARE BIOTA ON THE EREEN MINE SITE WITH ADJACENT NATIVE SITES.

HARE ON RECLAIMED AREA. PEABODY WINSWAY PHOTO

SOIL MICROORGANISMS (DILUTION PLATE COUNTS): FUNGI, BACTERIA, ACTINOMYCETES, N-FIXING ORGANISMS.

INSECTS: 42 SPECIES, 32 FAMLIES, 9 ORDERS: SOME DIFFERENCES BETWEEN RECLAIMED AND NATURAL AREAS

BIRDS: 31 SPECIES: RECLAIMED SITE COMPARABLE TO NATURAL AREAS.

MAMMALS: 5 REGISTERED IN THE RECLAIMED AREA. THESE ARE REPRESENTATIVE OF THE NATIVE SITES.

SUMMARY

- MINE LAND RECLAMATION IS POSSIBLE IN MONGOLIA
- SOME OF THE SITES IN MONGOLIA (E.G. TAVAN TOLGOI) WILL BE AMONG THE MOST CHALLENGING ON THE PLANET.
- MONGOLIA HAS A CHANCE TO BE A WORLD LEADER IN BALANCING DEVELOPMENT WITH CONSERVATION.



REFERENCES

Baatar, Ravjaagiin and S. E. Williams. 1998. Properties of Dark Chestnut Soils (Ustic Mollisols) of the Mongolian Steppe. In: (Anne Phelan, et al., eds.) Land Use In Temperate East Asia: Current Status and Future Trends. Proceedings from the Workshop, Beijing, China, March 5-8, 1998. Pages 65-72.

Mongolian Minerals Law. 2006. Accessed June 3, 2010.

Peabody Energy. 2008. Reclamation and Environmental Best Practice for Coal Mining Operations, Recommendations to the Mongolian Government. Developed by Peabody Energy, St Louis. 66 pages.

Peabody Winsway Resources LLC. 2012. FAUNA MONITORING OF EREEN RECLAIMED SITE. **Ch.Uuganbayar** *Biology Department, Mongolian State University of Agriculture, Mongolian Ornithological Society* and others. Report, 59 pps.

Rheinbraun Engineering und Wasser Gmbh. 2003. "Review of the Environmental and Social Policies and Practices for Mining in Mongolia." Rheinbraun Engineering Background Papers. Cologne.

Robinson, W. R. and G. B. Anosova. 2004. Mining and Mineral Development Management Policy in the Selenga River Watershed. Proceedings of Science for Watershed Conservation: Multidisciplinary Approaches for Natural Resource Management Conference (USGS) Ulan-Ude Russia and Ulanbaatar, Mongolia. Accessed June 3, 2010. http://www.sric.org/mining/docs/USGS-siberia.pdf

Surdam, R. C. 2008. Wyoming Energy Development in the Context of the Global Energy Economy. Wyoming State Geological Survey. Challenges in Geologic Resource Development No. 6, 38 pages

Tumenbayar, B.; M. Batbayar & R. Grayson. 2000. Environmental Hazard in Lake Baikal Watershed Posed by Mercury Placer in Mongolia. World Placer Journal 1. 26 pages.

Williams, S. E., J. L. Dodd, and J. A. Lockwood. 1994. A comparison of the soils of the Northern Mixed Prairie (North America) and grassland of the Mongolian Plateau (Asia). Proceedings of the International Symposium on Grassland Resources. Hohhot, Inner Mongolia, P.R.C. pages 335-344.

World Bank, The. 2006. Mongolia: A Review of Environmental and Social Impacts in the Mining Sector. Accessed June 3, 2010.

http://siteresources.worldbank.org/INTMONGOLIA/Resources/Mongolia-Mining.pdf